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Cai et al.

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(54) **DISPLAY DEVICE COMPRISING A COLOR FILTER LAYER WHEREIN A BLACK MATRIX PATTERN, A RED PIXEL PATTERN, AND A GREEN PIXEL PATTERN ARE DISPOSED IN DIFFERENT LAYERS**

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B82Y 20/00 (2011.01)

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(58) **Field of Classification Search**
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See application file for complete search history.

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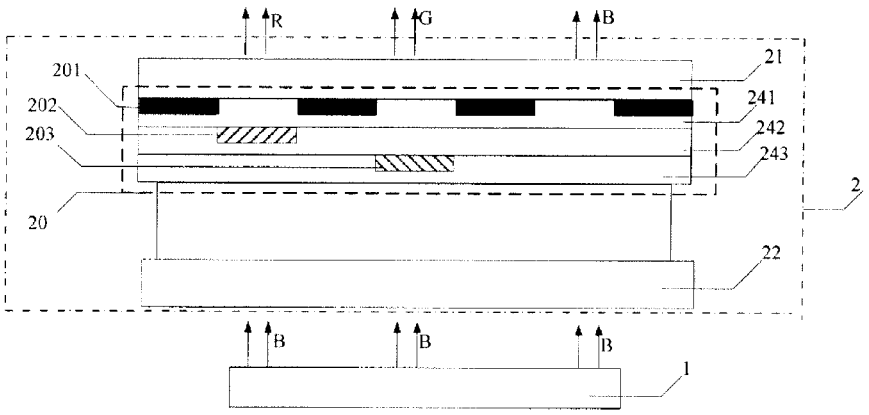
(57) **ABSTRACT**

A display device and a manufacturing method are provided. The display device includes a blue light backlight source and a liquid crystal display panel, and the liquid crystal display panel comprises a first substrate, a second substrate. The first substrate or the second substrate includes a color filter layer which includes a black matrix pattern and a red pixel pattern and a green pixel pattern. The red pixel pattern and the green pixel pattern are quantum dot material thin film patterns respectively emitting red light and green light under the excitement of blue light.

16 Claims, 2 Drawing Sheets



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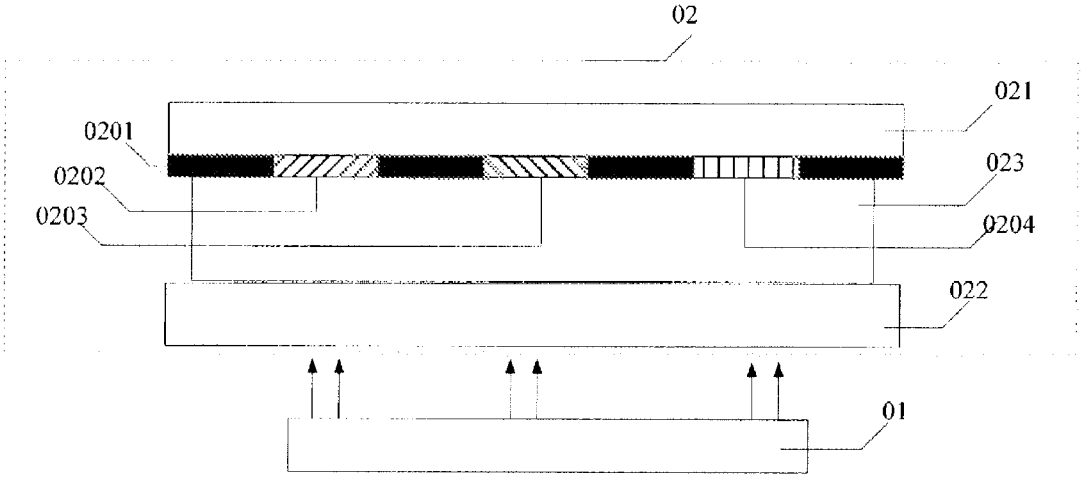
02
021
0201
023
0202
0204
0203
022
01

Fig. 1

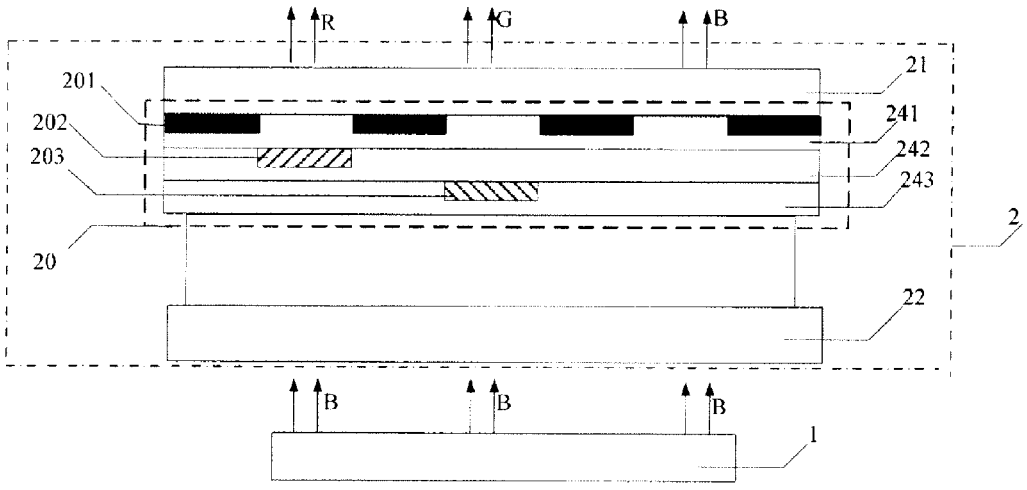
R
G
B
21
201
241
202
242
203
243
2
20
22
B
B
B
1

Fig. 2

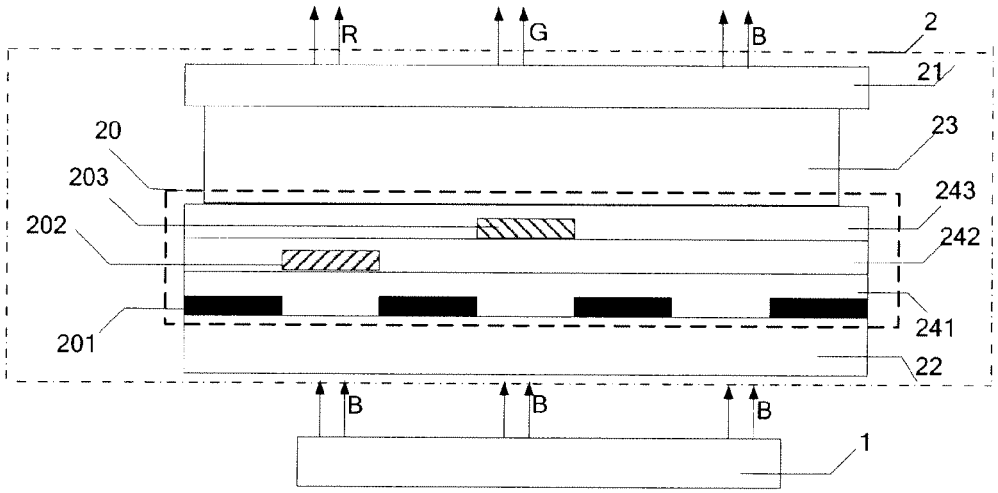
R
G
B
2
21
20
23
203
243
202
242
241
201
22
B
B
B
1

Fig. 3

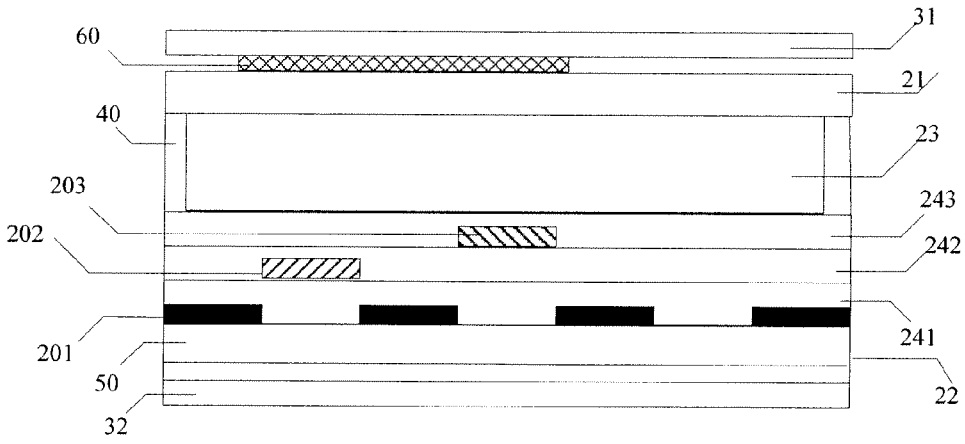
60
31
21
40
23
203
243
202
242
241
201
50
22
32

Fig. 4

DISPLAY DEVICE COMPRISING A COLOR FILTER LAYER WHEREIN A BLACK MATRIX PATTERN, A RED PIXEL PATTERN, AND A GREEN PIXEL PATTERN ARE DISPOSED IN DIFFERENT LAYERS

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims priority from Chinese National Application No. 20130022596.0filed on Jan. 22, 2013, the contents of which are incorporated herein by reference.

TECHNICAL FIELD

Embodiments of the present invention relates to a display device and a manufacturing method thereof.

BACKGROUND

The prior LCD display screen is to adhere a TFT substrate to a color filter substrate, as illustrated in FIG. **1**, it comprises a backlight source **01** and a liquid crystal display panel **02**. The liquid crystal display panel **02** comprises an upper substrate **021**, a lower substrate **022** and a liquid crystal material **023**. The upper substrate **021** comprises a black matrix **0201**, and a red pixel region **0202**, a green pixel region **0203** and a blue pixel region **0204** surrounded by black matrix patterns. A used white backlight is formed by mixing the yellow light and the blue light emitted by exciting a yttrium aluminum garnet (YAG) fluorescent powder using a blue chip, and the light emitting efficiency is low, the color is impure, and a relatively low color gamut is rendered after the filtration by the R\G\B of a color filter layer CF, and the color is not bright or real. Therefore, how to improve the performance has been a technical problem in the prior art.

The Quantum dot is generally nano particles composed of II-VI group or III-V group elements, and can emit fluorescent light after being excited. The light emitting spectrum can be controlled by varying the size of the quantum dot, and both the fluorescent intensity and the stability are fine, so it is a good photoluminescence material. There are a lot of quantum dots, and the representative ones are CdS/CdSe/CdTe/ZnO/ZnS/ZnSe/ZnTe and etc. in the II-VI group and GaAs, GaP, GaAs, GaSbi, HgS, HgSe, HgTe, InAs, InP, InSb, AlAs, AlP, AlSb and etc. in the III-V group. Quantum dots of the same material can emit different lights according to the produced size. Currently, the prior art already has the technical solution of applying quantum dot materials to a backlight source, which can improve the light emitting efficiency to a certain extent, but how to render a display device with a wide color gamut and high optical efficiency is still a technical problem in the prior art.

SUMMARY

One embodiment of the present invention provides a display device, comprising a blue light backlight source and a liquid crystal display panel, and the liquid crystal display panel comprises a first substrate, a second substrate and a liquid crystal layer between the first substrate and the second substrate, wherein the first substrate or the second substrate comprises a color filter layer which comprises a black matrix pattern and a red pixel pattern and a green pixel pattern; a first passivation layer is provided between the layer where the red pixel pattern or the green pixel pattern is located and layer where the black matrix pattern is located; a second passivation layer is provided between the layer where the red pixel pattern is located and the layer where the green pixel pattern is located; and the red pixel pattern and the green pixel pattern are quantum dot material thin film patterns respectively emitting red light and green light under the excitement of blue light.

Another embodiment of the present invention provides a manufacturing method of a display device, comprising: packaging a liquid crystal display panel and a blue light backlight source, wherein, a color filter layer is produced on the first substrate or the second substrate of the liquid crystal display panel, and steps of manufacturing the color filter layer comprise: forming a patterned black matrix pattern; forming a first passivation layer on the substrate formed with the black matrix pattern; forming a first color pixel pattern on the substrate formed with the first passivation layer; forming a second passivation layer on the substrate formed with the first color pixel pattern; forming a second color pixel pattern on the substrate formed with the second passivation layer; forming a third passivation layer on the substrate formed with the second color pixel pattern; wherein the first color pixel pattern and the second color pixel pattern are quantum dot material thin film patterns respectively emitting light of a first color and light of a second color under the excitement of blue light.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to clearly illustrate the technical solution of the embodiments of the invention, the drawings of the embodiments will be briefly described in the following; it is obvious that the described drawings are only related to some embodiments of the invention and thus are not limitative of the invention.

FIG. **1** is a schematic diagram of a structure of a display screen device in the prior art;

FIG. **2** is a schematic diagram of a structure of a display device provided by the embodiment of the present invention;

FIG. **3** is a schematic diagram of a structure of another display device provided by the embodiment of the present invention; and

FIG. **4** is a schematic diagram of a structure of the display panel in the structure illustrated in FIG. **3**.

DETAILED DESCRIPTION

In order to make objects, technical details and advantages of the embodiments of the invention apparent, the technical solutions of the embodiment will be described in a clearly and fully understandable way in connection with the drawings related to the embodiments of the invention. It is obvious that the described embodiments are just a part but not all of the embodiments of the invention. Based on the described embodiments herein, those skilled in the art can obtain other embodiment(s), without any inventive work, which should be within the scope of the invention.

Embodiments of the present invention provide a display device and a manufacturing method thereof, for solving technical problems of narrow color gamut and low optical efficiency of the display device in the prior art.

The present invention is further described in combination with the drawings as follows.

Referring to FIG. **2**, the embodiment of the present invention provides a display device, comprising a blue light backlight source **1** and a liquid crystal display panel **2**; the liquid crystal display panel comprises an upper substrate **21**, a lower substrate **22** and a liquid crystal layer **23** between the upper

substrate and the lower substrate. For example, the blue light backlight source **1**, the lower substrate **22**, the liquid crystal layer **23** and the upper substrate **21** are laminated sequentially, i.e., the blue light backlight source **1** is disposed at the lower substrate **22** side of the liquid crystal display panel.

The upper substrate **21** comprises a color filter layer **20**, and the color filter layer **20** comprises a black matrix pattern **201**, a red pixel pattern **202** and a green pixel pattern **203**; a first passivation layer **241** is provided between the layer where the red pixel pattern **202** is located and the layer where the black matrix pattern is located; a second passivation layer **242** is provided between the layer where the red pixel pattern **202** is located and the layer where the green pattern **203** is located; and a protection layer **243** is provided above the layer where the green pixel pattern **203** is located. The red pixel pattern and the green pixel pattern are quantum dot material thin film patterns respectively emitting red light and green light under the excitement of blue light.

In another embodiment, as illustrated in FIG. **3**, the lower substrate **22** comprises a color filter layer **20**, and the color filter layer **20** comprises a black matrix pattern **201**, a red pixel pattern **202** and a green pixel pattern **203**. A first passivation layer **241** is provided between the layer where the red pixel pattern **202** is located and the layer where the black matrix pattern is located; a second passivation layer **242** is provided between the layer where the red pixel pattern **202** is located and the layer where the green pattern **203** is located; and a protection layer **243** is provided above the layer where the green pixel pattern **203** is located. The red pixel pattern and the green pixel pattern are quantum dot material thin film patterns respectively emitting red light and green light under the excitement of blue light.

The above red pixel pattern **202** and the green pixel pattern **203** are respectively provided within the pixel region defined by the black matrix to form a red pixel region and a green pixel region. In addition, the pixel region defined by the black matrix further comprises a pixel region wherein the red pixel pattern **202** and the green pixel pattern **203** are not provided, thus, the blue light emitted from the backlight source can go through the pixel region to form a blue pixel region.

The blue light is used as the backlight source, and the quantum dot material is guided into the color filter layer to provide a red pixel pattern emitting red light under excitement of the blue light and a green pixel pattern emitting green light under excitement of the green light in the color filter layer. As quantum dot material after excitement emit light with a good monochromaticity and high intensity and stability, the display screen, compared with the traditional ones, has a wider color gamut and a higher optical efficiency. Meanwhile, as the blue light is used as the backlight source, the manufacturing of the blue pixel pattern in the color filter layer is omitted, and then the process flow and the cost are reduced. On the other hand, compared with the OLED organic light emitting layer in the prior art, as the quantum dot materials are inorganic light emitting materials and can not be oxidized or eroded by moisture, it is unnecessary to conduct the manufacturing process under the protection of vacuum or inert gas, and thereby the cost is reduced and the stability and working life are improved.

For example, the upper substrate comprises an upper glass substrate and a color filter layer, and the lower substrate comprises a TFT array substrate. For example, the layer where the black matrix pattern is located is above the layer where the red pixel pattern is located and the layer the green pixel pattern is located. By adopting this structure, it is necessary to assemble the upper substrate, the lower substrate and the liquid crystal material to form the liquid crystal display panel. The assembling process flow in the prior art is mature and easily achieved.

For example, the upper substrate comprises an upper glass substrate, and the lower substrate comprises a TFT array substrate and a color filter layer. For example, the layer where the black matrix pattern is located is below the layer where the red pixel pattern is located and the layer where the green pixel pattern is located. It is unnecessary to consider the technical problem rendered by the assembling of the upper substrate and the lower substrate when disposing the color filter layer on the lower substrate. For example, the assembling process in the prior art may render a certain deviation to the device, for example, a deviation larger than 5 μm, while the process deviation in manufacturing the mask of the black matrix pattern is about 1 μm. Therefore, the technical problem of deviation caused by the assembling is omitted by disposing the color filter layer on the lower substrate, and the aperture ratio can be improved to a certain extent.

For example, a blue light filter layer is provided above the red pixel pattern and the green pixel pattern. In the technical solution provided in the present invention, the blue light backlight source is used as an excitement light source on the one hand for exciting the red pixel pattern and the green pixel pattern to respectively emit red light and green light, and on the other hand, the blue light backlight source as the light source of blue pixel, constitutes the red, green and blue three primary colors together with the red and green lights, and they are combined to conduct colorful display of a picture. Due to the limitation of the manufacturing process, there may be residual blue light emitted out after the blue light goes through the red pixel pattern and the green pixel pattern, thus a blue light filter layer is provided above the red pixel pattern and the green pixel pattern, and adopts a blue filter material. The filter material is a material which can change the spectrum components or define the oscillation plane of the light. The blue filter material can absorb light with a wavelength less than 480 nm (blue light) and transmit light with a wavelength larger than 480 nm. Therefore, after going through the red pixel pattern and the green pixel pattern, the red light and green light can be emitted out completely, while the residual blue light will be absorbed and will not appear in the red pixel pattern or the green pixel pattern regions, thus the red, green and blue three primary color pixels with very high monochromaticity can be rendered. For example, taking the N-methyl-2-pyrrole formalin and rhodanine as the raw material, a rhodanine blue light merocyanine dye is synthesized under the catalysis of piperidine and is an existing dye used by synthesis. In addition, the blue light filter layer can be provided between the upper substrate and the upper polarizer of an external layer, or at other positions, as long as it can shield the residual blue light.

For example, the blue light backlight source is an LED backlight source. Compared with other light sources, the LED used as the backlight source has a good monochromaticity and a high LED optical efficiency.

For example, the quantum dot material is a nano-particle composed by II-VI group or III-V group elements. The quantum dot material adopted by the present invention is a mature quantum dot material in the current technology, for example, the CdS/CdSe/CdTe/ZnO/ZnS/ZnSe/ZnTe and etc. in II-VI group, and the GaAs, GaP, GaAs, GaSb, HgS, HgSe, HgTe, InAs, InP, InSb, AlAs, AlP, AlSb and etc. in III-V group. For quantum dot materials of the same substance, as the sizes of the quantum dots are different, i.e., the sizes of the nanoparticles are different, the lights emitted after excitement have different wavelengths. In the process of manufacturing the

red pixel pattern and the green pixel pattern, materials of the same substance but with different sizes are usually used.

For example, the thin film pattern has a thickness of 10-30 nm. As the sizes of the quantum dot materials are at nano level, the efficiency of the stimulated luminescence shall be 100% if a single layer distribution of the quantum dot material can be achieved, but the single layer distribution can hardly be achieved because of the limitation of manufacturing process and costs. In the embodiment of the present invention, the thin film pattern has an appropriate thickness of 10-30 nm, and it firstly is easily achieved in the process and can ensure the optical efficiency of the emitted light.

For example, the quantum dot material is ZnS, the quantum dots of the red pixel pattern have sizes of 9-10 nm, and the quantum dots of the green pixel pattern have sizes of 7-8 nm. As described above, there are a lot of quantum dot materials, but metals such as Cd and Hg are toxic, ZnS is preferable under identical manufacturing environment. Of course, other quantum dot materials can also be used as the material of the color filter layer. Compared with ZnS, it also be fine as long as a much more strict protection measure for the production is arranged.

The embodiment of the present invention provides a manufacturing method of a display device, in which the liquid crystal display panel and the blue backlight source are packaged. A color filter layer is produced on an upper substrate or a lower substrate of liquid crystal display panel, and the method of manufacturing the color filter layer comprises:

forming a patterned black matrix pattern;

forming a first passivation layer on the substrate formed with the black matrix pattern;

forming a red pixel pattern on the substrate formed with the first passivation layer;

forming a second passivation layer on the substrate where the red pixel pattern is formed;

forming a green pixel pattern on the substrate formed with the second passivation layer;

wherein, the red pixel pattern and the green pixel pattern respectively are quantum dot material thin film patterns respectively emitting red light and green light under the excitement of blue light.

The embodiment of the present invention provides another manufacturing method of the display device, in which the liquid crystal display panel and the blue light backlight source are packaged. A color filter layer is produced on an upper substrate or a lower substrate of the liquid crystal display panel, and the method of manufacturing the color filter layer comprises:

forming a patterned black matrix pattern;

forming a first passivation layer on the substrate formed with the black matrix pattern;

forming a green pixel pattern on the substrate formed with the first passivation layer;

forming a second passivation layer on the substrate formed with the red pixel pattern;

forming a red pixel pattern on the substrate formed with the second passivation layer; and

forming a third passivation layer on the substrate formed with the green pixel pattern;

wherein, the red pixel pattern and the green pixel pattern respectively are quantum dot material thin film patterns respectively emitting red light and green light under the excitement of blue light.

Furthermore, in the above manufacturing method, the steps of manufacturing the red pixel pattern and the green pixel pattern relate to the manufacturing method of the quantum dot thin film layer. There are a lot of manufacturing methods of the quantum dots, the embodiments of the present invention can use any suitable method to fabricate the quantum dots or can directly use those which are commercially available; the embodiment of the present invention can employ any suitable methods to fabricate the quantum dot thin film for the red pixel pattern and the green pixel pattern, such as spin coating. The process for fabricating the thin film may relate to a certain chemical conditions, comprising: mixing the quantum dot materials with an organic solvent and subsequently heating the organic solvent so that it can be evaporated, for example, as for the ZnS quantum dot material, the organic solvent can be absolute ethyl alcohol and etc., with a heating temperature about 100-200° C. In these chemical conditions, the already formed layers are not dissolved in the organic solvent and the manufacturing process therefore has been subjected to an annealing at 250° C., so the heating for evaporation will not affect the already formed layers.

The display panel in the display device provided by the present invention and the manufacturing method thereof will be described in details in connection with the drawings and the preferred embodiments. It is obvious that the present preferred embodiments are just for describing the invention clearly, but not a limitation to the present invention.

Referring to FIG. **4**, the display panel **2** in the display device in the present preferred embodiment comprises: an upper substrate **21**, a lower substrate **22**, a liquid crystal material **23** between the upper substrate **21** and the lower substrate **22**, and a sealant **40**; an upper polarizer **31** is disposed on the side of the upper substrate opposite to the liquid crystal material, and a lower polarizer **32** is disposed on the side of the lower substrate opposite to the liquid crystal material.

The upper substrate **21** is, for example, a glass substrate.

The lower substrate **22** comprises a color filter layer **20** and a TFT array substrate **50**; the color filter layer **20** comprises a black matrix pattern **201**, and a red pixel pattern **202** and a green pixel pattern **203**; a first passivation layer **241** is disposed between the layer where the red pixel pattern **202** or the green pixel pattern **203** is located and the layer where the black matrix is located; a second passivation layer **242** is disposed between the layer where the red pixel pattern **202** is located and the layer where the green pixel pattern **203** is located; and the layer where the black matrix pattern **201** is located is below the layer where the red pixel pattern **202** is located and the layer where the green pixel pattern **203** is located. The red pixel pattern and the green pixel pattern are quantum dot thin film patterns respectively emitting red light and green light under the excitement of the blue light. It should be described herein that the upper and lower positions of the layers where the red pixel pattern and the green pixel pattern are located can be exchanged, and the object of the present invention can also be achieved.

A patterned blue light filter layer **60** is provided between the upper substrate **21** and the upper polarizer **31**. In the direction perpendicular to the panel, the blue light filter layer **60** covers the red pixel pattern **202** and the green pixel pattern **203**, with a function of filtering the residual blue light. In the present preferred embodiment, 5-(1-methyl-2-pyrrole methyne) rhodanine is selected as the material of the blue light filter layer.

As for the method for fabricating the TFT array substrate **50**, it comprises: forming a gate line pattern on a glass substrate; manufacturing a gate insulating layer on a gate line layer; then forming drain/source electrodes and a data line layer to form the pattern of the TFT array (based on the manufacturing process, it can be divided into five processes and four processes); after the TFT is formed, forming a pixel

electrode layer and an insulating layer; and lastly, forming a strip-shaped common electrode layer on the uppermost layer of the TFT array substrate.

The manufacturing method of the present preferred embodiment is described in the following. Referring to FIG. **4**, firstly, a layer of the black matrix **201** designed by the pattern is produced on the TFT substrate; after the first passivation layer **241** is deposited and subjected to surface planarization, a layer of the red pixel pattern **202** is produced according to a designed pattern; then the second passivation layer **242** is deposited, and a layer of green pixel pattern **203** is produced on the second passivation layer **242** according to a designed pattern; and the third passivation layer **243** is deposited for protection. Specifically, the manufacturing process of the red pixel pattern **202** is taken as an example. The present preferred embodiment selects the ZnS quantum dot material, and the selected quantum dot material which emits red light is mixed into the organic solvent, and applied to the first passivation layer using a spin coating method, and then subjected to annealing to heat the organic solvent so that it is evaporated; and lastly a uniform red pixel pattern is formed. In the present preferred solution, the annealing temperature is selected to be 100-200° C., for example, it can be 150° C. The temperature of 250° C. will not affect the already formed layers, thus the annealing temperature in the present preferred technical solution is appropriate.

As a blue backlight is selected for direct illumination, it is unnecessary to produce the blue pixel layer. Thus, the COA (CF on Array) substrate based on the quantum dot technology is accomplished.

After a liquid crystal **23** is dripped, an upper substrate **21** with a blue light filter layer **60** is adhered; and the upper and lower substrates are respectively adhered to the upper polarizer **31** and the lower polarizer **32**. Thus, the manufacturing of the liquid crystal display panel is accomplished. Then, the produced liquid crystal display panel is packaged with the backlight source to form the display device.

A blue LED backlight **1** is selected for illumination, and high-purity red light is emitted after the conversion by the red pixel pattern **202** and the filtration of the blue light filter layer **60**; high-purity green light is emitted after the conversion by the green pixel pattern **203** and the filtration of the blue light filter layer **60**; and the high-purity blue backlight of the backlight **1** is directly emitted, and then the R/G/B three primary colors can be rendered, and all kinds of necessary bright colors can be rendered by controlling the R/G/B gray scales with the liquid crystal layer.

To sum up, the embodiments of the present invention provide a display device and a manufacturing method, wherein the blue light is used as the backlight source, the quantum dot material is introduced into the color filter layer, a red pixel pattern which emits red light after the excitement of the blue light and a green pixel pattern which emits green light after the excitement of the blue light are respectively provided in the color filter layer; as the light emitted from the quantum dot material after excitement has good monochromaticity, and high intensity and stability, the display screen thus produced, compared with the traditional display screen, has a wider color gamut and higher optical efficiency. Meanwhile, as the blue light is adopted as the backlight source, the manufacturing of the blue pixel pattern is omitted in the color filter layer, thus the process flow and the costs are reduced. In addition, the arrangement of the blue light filter layer increases the purity of the emitted light; and as for the technical solution of manufacturing the color filter layer on the lower substrate, it is unnecessary to consider the deviation of the assembling of the color filter with the TFT array substrate, and thus a high aperture ratio is kept. The quantum dot material is an inorganic material, the manufacturing process does not need the protection of vacuum condition or inert gas, and thereby the manufacturing cost is reduced.

The foregoing is merely exemplary embodiments of the invention, but is not used to limit the protection scope of the invention. The protection scope of the invention shall be defined by the attached claims.

The invention claimed is:

1. A display device, comprising a blue light backlight source and a liquid crystal display panel, and the liquid crystal display panel comprising a first substrate, a second substrate and a liquid crystal layer between the first substrate and the second substrate, wherein,

the first substrate or the second substrate comprises a color filter layer which comprises a black matrix pattern and a red pixel pattern and a green pixel pattern,

wherein the black matrix pattern, the red pixel pattern and the green pixel pattern are disposed in different layers from each other;

a first passivation layer is provided between a layer where the red pixel pattern or the green pixel pattern is located and a layer where the black matrix pattern is located;

a second passivation layer is provided between the layer where the red pixel pattern is located and the layer where the green pixel pattern is located; and

the red pixel pattern and the green pixel pattern are quantum dot material thin film patterns respectively emitting red light and green light under the excitement of blue light.

2. The device according to claim **1**, wherein, the first substrate comprises a glass substrate and a color filter layer formed on the glass substrate, and the second substrate comprises a TFT array substrate; and the layer where the black matrix pattern is located is closer to the blue light backlight source side than the layer where the red pixel pattern is located and the layer where the green pixel pattern is located.

3. The device according to claim **1**, wherein, the first substrate comprises a glass substrate, and the second substrate comprises a TFT array substrate and a color filter layer; wherein, the layer where the black matrix pattern is located is closer to the blue light backlight source side than the layer where the red pixel pattern is located and the layer where the green pixel pattern is located.

4. The device according to claim **1**, wherein, a blue light filter layer is provided at sides of the red pixel pattern and the green pixel pattern opposite to the blue light backlight source.

5. The device according to claim **2**, wherein, a blue light filter layer is provided at sides of the red pixel pattern and the green pixel pattern opposite to the blue light backlight source.

6. The device according to claim **3**, wherein, a blue light filter layer is provided at sides of the red pixel pattern and the green pixel pattern opposite to the blue light backlight source.

7. The device according to claim **1**, wherein, the blue light backlight source is an LED backlight source.

8. The device according to claim **1**, wherein, the quantum dot material is a nano particle composed of II-VI group elements or III-V group elements.

9. The device according to claim **1**, wherein, the quantum dot material thin film pattern has a thickness of 10-30 nm.

10. The device according to claim **1**, wherein, the quantum dot material is ZnS, the quantum dot of the red pixel pattern has a size of 9-10 nm, and the quantum dot of the green pixel pattern has a size of 7-8 nm.

11. The device according to claim **1**, wherein, the black matrix defines a plurality of pixel regions, and the green pixel

pattern and the red pixel pattern are respectively located in different pixel regions to form a green pixel region and a red pixel region.

12. The device according to claim **11**, wherein, the plurality of pixel regions further comprise a plurality of blue pixel regions in which the green pixel pattern and the red pixel pattern are not provided.

13. The device according to claim **1**, wherein, the blue backlight source is provided at the second substrate side of the liquid crystal display panel.

14. The device according to claim **2**, wherein, the blue backlight source is provided at the second substrate side of the liquid crystal display panel.

15. The device according to claim **3**, wherein, the blue backlight source is provided at the second substrate side of the liquid crystal display panel.

16. The device according to claim **11**, wherein, the blue backlight source is provided at the second substrate side of the liquid crystal display panel.

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